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INTRODUCTION

Since its establishment and subsequent development in the decade 1980-1989, the International Lithosphere Program (ILP) has been an important addition to international earth science research, having accomplished an ambitious program and promoted numerous initatives. The increasing awareness of global cycles, feed-back mechanisms, non-linear processes, etc have lead to the emergence of programs such as the Geosphere-Biosphere (IGBP), Global Change and Earth System Programs. Many phenomena in the diverse fields that link the various earth systems, which had been previously studied as separate entities of the geosphere, biosphere, hydrosphere and atmosphere, are now being investigated within an integrated framework. The conjunction of solid earth, atmospheric, ocean and biological sciences that include: geophysics, geology, geochemistry, atmospheric sciences, biology, ecology, environmental sciences, oceanography, and many others fields will provide a global paradigm.

Activities of the Mexican National Committee for the Lithosphere Program have been mainly concentrated in the planning, editing and printing of publications and conferences and with organizational aspects of ILP-related projects. Major objectives of the Committee are to foster and encourage studies within the scope of the ILP and specific interests of the Mexican geoscience community. The Committee has no direct economic support for research programs.

Several research projects are being carried out in the country by various national and international groups; it is not intended to provide a comprehensive review here. Most long-term projects described previously are still underway, in particular those concerned with tectonics, deep crustal and upper mantle structure, seismicity and natural hazards.

Interest on the structure and nature of the lithosphere has continued to increase. The Geolimex group completed a 400 km long seismic refraction experiment in southern Mexico, from the Pacific ocean to the Gulf of Mexico during May-June, 1992. Deep magnetotelluric (MT) surveys have also been conducted by two groups along the same transect during November 1991 and May-August 1992. The paper by Arzate *et al.*, (this volume) describes the initial findings of the studies. The MT transect crosses from the active Middle America trench into an assamblage of Precambrian, Paleozoic and Mesozoic terranes and across the passive margin of the Gulf of Mexico. Other multinational research groups have also completed seismic refraction studies across the Pacific continental margin and in the central volcanic arc.

Another project specifically aimed at the Global Geoscience Transect Program of ILP is the transect along the 28th parallel which integrates data and new modeling of seismic refraction, gravity, magnetics, magnetotellurics, heat flow, mantle and crustal xenoliths and regional geology (Campos-Enriquez *et al.*, 1992).

Contributions from Mexico to the World Stress Map project have been included in a special issue of the *Journal of Geophysical Research* and the colour world stress map (Suter *et al.*, 1992).

Several projects on neotectonics of various parts of the country have been implemented in the past two years. Studies in the central volcanic arc and on the extension of the Basin and Range province have provided interesting new data (e.g., Suter *et al.*, 1992; Garduño-Monroy *et al.*, this volume). Participation in the projects on World Map of Major Active Faults and Paleoseismicity of the Late Holocene is already being planned.

Modeling and interpretation of regional gravity and aeromagnetic data in the volcanic arc have provided new insights into the relationships among magmatic activity, subduction process, tectonics, inherited zones of weakness, and crustal structure (e.g., Urrutia-Fucugauchi and Molina-Garza, 1992).

Studies on past global changes have been initiated by several groups and the past two years have been very busy. Interdisciplinary projects are being completed in the lacustrine system of the Basin of Mexico, which is the site of one of the largest megacities of the world (e.g., Lozano-García *et al.*, in press). Several projects are also addressing regions in the volcanic arc (Metcalfe, 1992) and in the arid regions of northern Mexico (e.g., Ortega, in press). A National Committee for the IGBP has recently been organized under the sponsorship of the National Council of Science and Technology (CONACYT).

Paleomagnetic studies have continued to provide data on paleolatitude relations for the various paleoelements of Mexico and on the evolution of the Gulf of Mexico-Caribbean Sea region (e.g., Ortega-Guerrero and Urrutia-Fucugauchi, this volume). Geologic studies and paleogeographic syntheses have also provided important data on the evolution of southern Mexico (e.g., Morán-Zenteno *et al.*, this volume). Projects on tectonics, paleomagnetism and structural geology are being conducted in the Cenozoic

volcanics of the Chihuahuan 'Basin and Range' province, the Sierra Madre Occidental and Mesozoic sediments in northern Mexico, in the Tierra Caliente complex of central and southern Mexico (e.g., Tolson; González-Partida; Delgado *et al.;* this volume), in the western sector of the volcanic arc, includying the Jalisco block, the Acambay graben and the Michoacán-Guanajuato volcanic field, and in the terranes along the southern Mexico continental margin and the Yucatan block (e.g., Sager *et al.*, 1992; Molina-Garza *et al.*, 1992; Nowicki *et al.*, 1993).

Studies related to the Cretaceous/Tertiary boundary (K/T) events have recently been concentrated on the Chicxulub structure of northern Yucatan peninsula, which may be the long-sought K/T impact crater. The structure, first identified in regional gravity and magnetic surveys conducted by PEMEX Oil Company has a large size, in the order of 200 km rim diameter (or larger), and an "andesitic" and breccia body interpreted as the impact melt. Ar/Ar dating and paleomagnetic studies support a K/T age (Sharpton *et al.*, 1992). Projects addressing several aspects of the Chicxulub structure and in the circum-Gulf of Mexico and Caribbean K/T sections will surely increase in number and scope in the near future. Studies have already focused on interpreted "mega-tsunami" deposits associated with the meteorite impact in e.g., northern Mexico and the Caribbean. Shallow and deep drilling in the structure is planned as part of the interdisciplinary projects.

As part of the major activities of the Committee, a series of thematic volumes have been published. Four special Lithosphere volumes had already appeared: *Geofísica Internacional,* vol. 25, no. 1 (1986); vol. 25, no 4 (1986); vol. 27, no. 4 (1988); and vol. 28, no. 5 (1989).

The present Special Volume, prepared on the themes of "Tectonics, Magmatism and Crustal Stucture of Mexico", includes 10 papers by 21 authors. For the present volume as in the past, it has been attempted to include papers with geophysical and geological emphasis, trying to encourage interdisciplinary studies.

The first three contributions are concerned with the Tierra Caliente complex, which is one of the major metamorphic crystalline terranes in southern Mexico. The complex is mainly composed by a sequence of eugeosynclinal sediments and volcanics of probable Mesozoic age that have been deformed and metamorphosed.

In the first paper, G. Tolson (presently at Univ. Munich, Germany) reports on a detailed study of the metamorphosed volcanic sedimentary sequence of the Santa Rosa Area, SW Mexico State, central Mexico. Metamorphic rocks are part of the Tierra Caliente Complex that has been interpreted as a Mesozoic eugeosynclinal assemblage with a complex history of various deformational and metamorphic events. The study comprised a 1:15 000 geologic mapping and structural and tectonic analyses. Tolson develops a regional tectonic model for the evolution of southern Mexico during Mesozoic and Cenozoic times and suggests several research themes for further investigation: geochemical studies of the metavolcanics to document genetic associations and estimate subduction geometry, geochronological studies to constraint magmatic, metamorphic and deformational events, and further structural analysis to establish the kinematics and dynamics of the evolution of the region. The tectonic model comprises a complex sequence of island arc construction and repeated back-arc development and collapse during the Mesozoic.

In the next paper, L. A. Delgado-Argote and co-workers (CICESE, Ensenada, Mexico) present results of a study of the San Pedro Limón-Palmar Chico area in the Tierra Caliente Complex. They report results of hydrogen isotopes on structural waters from serpentinites and chrysotile and infrared spectroscopy on partly to completely serpentinized ultramafics. They conclude that serpentinization occurred at low temperatures under kinetic conditions. The main serpentinization phase is then related to a transpressive regime where mechanical intrusive emplacement produced local hydrothermal conditions.

In the next paper, E. González-Partida (IIE, Cuernavaca, Mexico) reports results of a combined petrographic, geochemical, fluid inclusion and crystallo-chemical study of fluids associated with a metamorphic section of the Tierra Caliente Complex. He concludes that the rocks analyzed correspond to initial illite clay sediments with mature sedimentation characteristics and that transformation to biotite and muscovite was due to epizonal metamorphism.

The next paper by J. A. Arzate and co-workers (Montreal, Canada and UNAM, Mexico) presents the results of a magnetotelluric and gravity study of the crustal structure and subduction zone of southern Mexico. These geophysical methods have been successfuly applied in the past for investigation of the lithosphere structure at passive and active continental margins (e. g., Kurts *et al.*, 1986). The study was designed to investigate the crustal structure of the continental margin, the terranes inland, terrane sutures and the active plate subduction process. The paper reports on the initial models that provide a regional simplified view of this complex region.

The following paper by D. J. Morán-Zenteno and co-workers (UNAM, Mexico) report on geologic studies of several critical areas in the northern Mixteca terrane, southern Mexico and on the paleogeographic evolution during Jurassic-Cretaceous times. They report detailed stratigraphic analyses of three areas in southern Puebla and northern Oaxaca: Coyotepec-Tianguistengo, Huajuapan-Petlalcingo, and Tezoatlan-Diquiyú. According to their results, there is no evidence to support middle-late Jurassic paleogeographic affinities between areas nowdays located north and south of the Trans-Mexican volcanic belt (TMVB). This interpretation is consistent with models that propose the belt as a major crustal discontinuity active during the opening of the Gulf of Mexico.

The next paper by B. Ortega-Guerrero and J. Urrutia-Fucugauchi (UNAM, Mexico) presents results of a paleomagnetic and structural study of the Jurassic sedimentary sequence of the Ixcaquixtla region, within the northern sector of the Mixteca terrane. Early paleomagnetic studies have interpreted the data in terms of vertical axis rotations (e.g., Morán-Zenteno *et al.*, 1988; Fang *et al.*, 1989). The new paleomagnetic results for two continental red bed sequences give paleolatitude estimates of 2.2° ± 5.6° for the early Jurassic and 12.8° ± 7.9° for the middle Jurassic. Reinterpretation of the time sequence of paleomagnetic records for units studied within the Mixteca terrane give an apparently simple picture in which the terrane is located some 8-10 degrees north of its present relative positions during Jurassic times, possibly attached to the western North American margin. The age of magnetization acquisition for the studied units remains the main limitation in this model. Southward motion of the terrane was completed before Albian-Cenomanian times (Urrutia-Fucugauchi, 1988).

In the next paper, V. H. Garduño-Monroy and coworkers (Univ. Milan, Italy) present a study of the Chapala Lake region, Jalisco State, western Mexico. They develop a regional stratigraphy for the volcanics and sediments within the Chapala graben. They observe two dominant lineament trends with orientations N90 E and N135 E-N180 E, which they associate with the opening of the Chapala graben at the end of the Miocene and Neogene deformation, respectively. Garduño-Monroy *et al.* interpret the Chapala graben in terms of an aulacogen.

The following paper by J. Yamamoto (UNAM, Mexico) presents results of a study of the microseismic activity in the Canatlán area, Durango State, northern Mexico. The region studied lies to the north of Durango City close to the volcanic plateau of the Sierra Madre Occidental (SMO). The main events present a magnitude mb of about 3.1. The seismic activity is shallow (some 1 to 5.5 km deep) and is distributed along two bands N21°W and N71°E. They are associated by Yamamoto to a conjugate fault system; the former trend coinciding with old normal faults related to the SMO. There is relatively little information on the seismicity of the central Altiplano and northern Mexico. There are some reports on occasional large earthquakes such as the 1887 (M=7.4) Sonora earthquake (Natali and Sbar, 1982), the 1931 Valentine, Texas earthquake (Doser, 1987) and the 1928 (M=6.3) Parral earthquake (Doser and Rodríguez, 1993). There seems to be no clear relationship with e.g., Basin and Range extension or stress state determinations.

H. Delgado-Granados and A.L. Martin del Pozzo (UNAM, Mexico) present a study of the volcanic units in the southern Basin of Mexico. They concentrate on the junction of the Las Cruces, Chichinautzin and Ajusco volcanic ranges. They identify 3 eruptive periods during the late Pliocene-early Pleistocene (Las Cruces), middle Pleistocene (Ajusco) and late Pleistocene-Holocene (Chichinautzin). They suggest that volcanoes from the three different periods (i.e., Picachos, Ajusco and Panza volcanoes) lie along a fracture system oriented N65 W that has been active at least since late Pliocene times. Glacial periods have affected the volcanic ranges (e.g., White and Valastro, 1984) and the authors discuss possible correlations.

The last contribution by J. Urrutia-Fucugauchi and A. L. Martin del Pozzo (UNAM, Mexico) is also concerned with the volcanic activity in the southern Basin of Mexico. They present new paleomagnetic data for the young volcanic units of the Chichinautzin Formation and discuss the implications of the paleomagnetic data for dating the age range of the activity. The onset of volcanic activity in Chichinautzin has often been associated with the closure of the Basin of Mexico and the development of the lake system. Units studied in Chichinautzin have consistently been giving normal polarities and assigned to the Brunhes Chron (0.78-0.79 Ma to present). However, units studied come from the upper part of the sequence and may give a biased view of Chichinautzin activity. Further studies on samples from deep drilling and the basal parts of the formation are required to estimate the beginning of volcanic activity.

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